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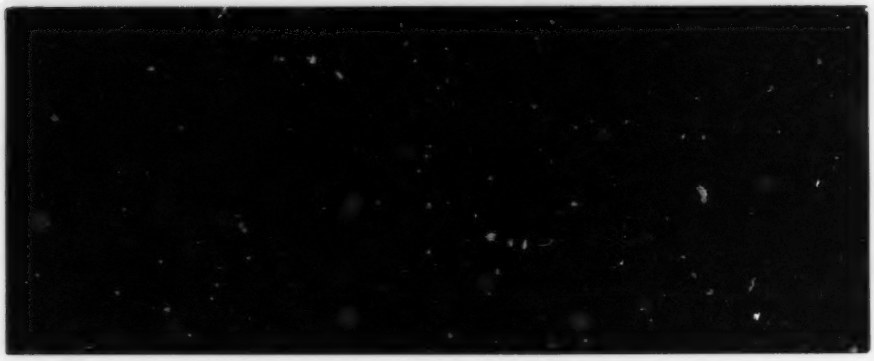

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Intensification of Sheep Production Under Prairie Conditions

S-85-01-0017/5-85-41
5-84-19
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RAWLINGS

INTENSIFICATION OF SHEEP PRODUCTION UNDER PRAIRIE CONDITIONS

N.C. Rawlings, W.E. Howell

ABSTRACT

This project is designed to increase ewe productivity by enhancing fertility and breeding ewes 3 times in 2 years. It is also an aim to spread the supply of lamb across the year by breeding ewes at spaced and predetermined times throughout the year. A scheme is being evaluated whereby a flock of ewes of breeds found on the Prairies is split in two. The 2 groups are bred 3 times in 2 years, with breeding spaced 4 months out of phase, using estrous synchronization, day length manipulations and a variety of other techniques. A thorough examination of the economics and managerial requirements for intensified production are an integral part of the study. The project was initiated in August of 1982 and the intensive flocks have now completed at least 1 production cycle (3 lambings, 2 years). Results have been encouraging but have also emphasized the need for rigid culling, excellent nutrition and selection of young healthy and prolific ewes.

BACKGROUND AND OBJECTIVES

The ewe is a seasonal breeder, being in season from early fall until late winter and lambing in late winter or early spring (gestation length 147 days). The ewe comes into estrus, or will allow the ram to mate, for a period of 36 hours every 17 days, until she conceives and then cyclicity ceases. Ewes can be prevented from coming into estrus by giving them the hormone progesterone. A group of cycling ewes (in the breeding season) can be made to come into estrus over a period of 2 days (estrus synchronization) by giving them all progesterone for 12 days and then withdrawing the progesterone. The progesterone is given in an intravaginal sponge, left in place for 12 days. This treatment, combined with an injection of a hormone called pregnant mares serum gonadotropin (P.M.S.G.), can also be used to induce, or force, a non cycling ewe to come into estrus and ovulate (i.e., in the non breeding season March to September). Generally fertility to synchronized breedings out of season is low. This can be improved by exposing the ewes to several weeks of very long days (e.g., 18 hours of light) followed by decreasing day length (daily light exposure) for several months, prior to breeding. This induces reproductive activity and improves fertility. Artificial insemination with extended fresh semen at fixed times after synchronization treatments may also help to improve fertility.

Not all ewes conceive to first estrus, whether it be natural or synchronized. To put ewes into small synchronized groups and to get them rebred efficiently after lambing, it is important to know, soon after mating, whether they are pregnant or not. No external method can detect pregnancy any earlier than 50 to 60 days after mating. However, 16 to 20 days after mating, non conceiving ewes

will have low blood levels of progesterone, whereas pregnant ewes have high blood progesterone. Laboratory analysis of a single blood sample at day 17 allows us to determine which ewes are pregnant.

During the last 40 days of pregnancy the nutritional status of the ewe is critical, analysis of a single blood sample for the hormone progesterone at 90 to 100 days of gestation allows us to determine which ewes are still pregnant and which ones are carrying single versus multiple pregnancies. Finally, treatment of ewes with high levels of estrogens near term (days 143/144) can synchronize lambing. The purpose of the present study is to utilize techniques for reproductive management in an overall scheme for intensifying fat lamb production under commercial conditions. This scheme has 3 basic goals: (1) increasing ewe fertility; (2) producing 3 lamb crops in 2 years; (3) spreading the supply of finished lamb across the year. To disseminate information to producers. More specific goals are as follows:

(a) Investigate the efficacy of repeated controlled breeding with day length manipulation in the long term.
(b) Investigate the managerial, flock health and nutritional requirements of ewes in an intensified production scheme over several years.
(c) Investigate the suitability of different breed types for use in intensified production and the effect of intensive production on ewe longevity.
(d) To collect input data to allow an economic evluation of the scheme.
(e) To further study the usefulness of various forms of pregnancy diagnosis.
(f) To study the applicability of A.I. and induced lambing in controlled breeding.
(g) To develop new techniques and appraches for reproductive management in the ewe.

EXPERIMENTAL METHODS

The project is set up to run 3 to 5 years initially, to meet the goals above. It is hoped to transfer the scheme to producers farms toward the end of this period. The University flock of 300 ewes was split into 3 groups of 100 ewes. Each group comprised 20 ewes of each of the following breeds or breed types: Rambouillet, Columbia, Suffolk, FinnxRambouillet, FinnxColumbia. An extra category of ewe, the FinnxSuffolk ewe was added during the first and second year of the project as ewe lambs were produced. Over the last year, due to University budgetary constraints, the pure bred Columbia ewes were removed. The FinnxColumbia crossbred ewes will be reduced by attrition. In addition, the remaining groups of ewes were reduced to 16 ewes per breed, per flock. One group of ewes serves as a control flock for economic evaluation, being bred naturally and lambing once a year. The other 2 flocks are intensively managed to lamb 3 times in 2 years, with the two groups lambing 4 months out of phase. This gives 6 lambings in 2 years increasing ewe output and spreading the flow of finished lamb.

The intensively managed ewes are bred at estrus synchronized by projestin containing intravaginal sponges inserted for 12 days. All ewes are treated with the drug P.M.S.G. (pregnant mares serum gonadotropin) at sponge removal, in an effort to increase ovulation rate and fertility. Rams are semen tested prior to every breeding and introduced at sponge removal, at a ratio of 1 ram to 10 ewes, and allowed to breed ewes at the synchronized estrus and one subsequent estrus. Ewes are blood sampled 20 days after sponge removal for pregnancy diagnosis, based on serum progesterone levels. Out of the regular breeding season, ewes are subjected to day length manipulation to make them become reproductively active and to improve fertility to out of season breeding. Day length manipulation is achieved by confining ewes to a crudely light proofed barn for a portion of the day, so that the length of light exposure can be manipulated using uncandescent bulbs and a timer. In our scheme, ewes to be bred in May are subjected to 1 month of 18 hours of light daily in January and then day length is reduced 30 minutes per week until breeding.

A serum progesterone test for pregnancy is repeated between 90 and 100 days of pregnancy. Open ewes at this stage are transferred to the other intensive breeding groups for rebreeding. Various drugs are being tested for induced lambing. Weaning occurs at 5 to 7 weeks after lambing and ewes have to be rapidly reprepared for breeding. Rams are routinely evaluated and semen tested by artificial vagina and teaser ewes. The usefulness of A.I. in improving fertility to synchronized breeding is beng investigated. Ewes are weighed at lambing, weaning and rebreeding and more recently body condition scores have been collected at sponging, sponge removal, bleedings, lambing and weaning.

Over the last year particular emphasis has been placed on the nutritional requirements of the intensively managed ewe. Requirements based on recent research findings and in excess of N.R.C. standards, have been drawn up and we are attempting to analyze all feeds utilized and to balance diets for intensified production. This is being done however within the constraints of available feeds and on the basis of feeding forrages and barley supplements; in order to operate the project under conditions that could readily be reproduced on Saskatchewan farms. The new feeding standards are attached as an appendix to this report.

During the year further studies were made of induced parturition using estrogen treatments (estradiol benzoate). Spring bred ewes were randomly divided into 4 groups as follows:

(1) Control group: 12 ewes. Each ewe was given 1 ml of saline on days 142 and 143 of pregnancy.
(2) Eight AM once group: 9 ewes. Each ewe was given a single 2 mg intramuscular injection of estradiol benzoate at 8 am on day 142.
(3) Eight AM twice group: 9 ewes. Each ewe was given a 2 mg intramuscular injection of estradiol benzoate at 8 am on days 142 and 143.
(4) Eight PM twice group: 9 ewes. Each was given a 2 mg intramuscular injection of estradiol benzoate at 8 pm on days 142 and 143.

RESULTS AND DISCUSSION

The present project was initiated in August of 1982. As can be seen in Tables 1 and 2, ewes in flock 1 (intensive) have now lambed 4 times and ewes in flocks 2 (intensive) and 3 (control) 3 times. As all of the intensively manged ewes have now completed a production cycle (i.e. 3 lambings in 2 years). The data for production has been expressed for the first 2 year production cycle in Tables 3 and 4. As can be seen in Tables 3 and 4 the number of lambs born per 100 ewes lambing was not depressed by intensified production. On average, but not in all groups, the number of ewes lambing of these put to the rams was depressed in the intensively managed ewes. Looking at Table 1 it would appear that the major reason for this was the reduced fertility to out of season breding. We have shown previously that the out of season breeding regime used in this study can produce good results in all the breeds of sheep used. It would appear that the pressure of intensification is most critically seen out of season. We feel that the feeding regime applied during the first production cycle (forrages with oat supplementation based on N.R.C. recommendations) was clearly inadequate. The nutritional inadequacy was noted especially in lactating ewes and this lowered subsequent fertility, especially to out of season breeding. As the second production cycle started the nutritional regime was improved (see appendix) and the results in Tables 1 and 2 of the most recent lambing of the control flock reflect this. In Table 5 the annual output of lambs for intensively and nonintensively managed ewes, based on a 2 year production cycle is shown. The increase in production for intensively managed ewes should be at least 50%, this was only attained by 2 breeds of ewes. Although more prolific, the Finn cross ewes are clearly more susceptible to inadequate nutrition under intensive conditions.

Lamb mortality to weaning has averaged 8.42% for the control flock and 9.77% for the intensively managed ewes. These figures are elevated by a few high values, losses have been variable, but showed no trend by season or breed. At the onset of the project the flock contained a good number of old ewes, the composition now is much younger, on average. Over the first two years of the study, based on the original number of ewes, a total of 17% of the ewes were lost by death and 51% by culling. Of the death losses chronic pneumonia accounted for the largest proportion. Of ewes culled, 33% were culled from the intensively managed flocks and 18% from the control flocks. Chronic wasting conditions (21%), udder problems (especially mastitis) (11%) and infertility (6%) accounted for the largest proportion of ewes culled. It is known that several wasting conditions such as Johnie's disease and chronic pneumonias are prevalent in prairie sheep. These problems often don't appear as clinical problems until a ewe ages or is stressed. Clearly, increased production pressure hastens the onset of loss due to these diseases. The losses due to mastitis emphasize the need for better management of the early weaned ewe under intensive management. This area is currently being addressed.

Pregnancy diagnosis performed on ewes in the intensive production groups at 19 days after sponge removal was 88% accurate in

predicting ewes that would lamb. A similar test in late pregnancy was 95% accurate. The results of induced lambings are shown in Table 6. Our aim was to see if such treatments could tighten up the lambing period and also to see if the number of treatments, or time of day of initiation of treatment affected the results. As can be seen in Table 6, the treatments were all equally effective. There were no deleterious effects on lambing or lamb survival. The treatment used in this case is simple, cheap and reduced the lambing period to 2.5 days, compared to 5 days in the control ewes. If a group of ewes were bred to a synchronized estrus they could be treated with estrogen as soon as the first 5 to 10% had lambed, giving a short and manageable lambing period.

The results obtained in this project so far, are encouraging, but also provide a challenge and some direction for areas where intensified production requires improved management. Clearly, in moving to intensified production the ewe is under more stress and there is a greater need to cull all unproductive and unthrifty ewes. We have culled heavily to remove problem ewes and we are blood testing ewes to detect carriers of several chronic wasting diseases. We appear to be establishing a group of productive ewes. All aspects of management need to be excellent, but we have noted that record keeping, nutrition, handling of the newborn lamb and the process of weaning are particularly critical. Our record keeping process has been revamped and new standards for nutrition (in excess of normal NRC recommendations) drawn up (appendix). Our management of the newborn lamb has been emphasized, as well as the procedures for weaning. Clearly young vigorous and productive ewes are required for intensive production and their management has to be of very high calibre. We feel the results of the first production cycle for our intensively managed ewes are very good considering the adjustments that have had to be made. In our second production cycle it should be possible, with the present calibre of the flocks and the requisite adjustments in management, to demonstrate the potential of intensified fat lamb production.

IMPACT

The sheep industry in Saskatchewan and Western Canada is small. Until recently it had been growing. Despite the present economic environment there is a buoyancy in the industry and renewed enthusiasm for sheep production. Because of the size of the industry and its secondary nature on many farms, little new technology is used. Ewes are generally bred once a year and productivity is low. Organized marketing although in existence, is hampered by the seasonal nature of production. Sheep are a useful side line for producers, converting grains into meat and utilizing marginal forages. However, with new and existing technology very high levels of productivity are being obtained elsewhere in the world. There is a current demand for lamb in Canada, one that is largely filled by foreign producers. If productivity could be raised and orderly marketing facilitated by year round lamb availability then sheep production could be as viable as any other form in livestock.

Table 1. The percentage of ewes lambing of those put to the ram in each breeding of the three flocks.

Group	Breeding	Breed of ewe					
		Col	Suff	Ramb	ColxFin	RambxFin	SuffxFin
#1	1	88	85	95	65	78	--
	2	59	44	35	47	56	--
	3	95	84	95	94	91	100
	4	--	95	83	79	81	89
#2	1	90	86	95	100	100	--
	2	67	64	71	91	80	88
	3	55	58	44	80	44	80
#3	1	90	90	84	97	100	78
	2	57	74	95	100	90	100
	3	--	81	100	100	94	100

Table 2. The number of lambs per 100 ewes lambing for each breeding of the three flocks.

Group	Breeding	Breed of ewe					
		Col	Suff	Ramb	ColxFin	RambxFin	SuffxFin
#1	1	113	176	156	215	235	--
	2	140	188	167	167	167	--
	3	184	206	153	275	258	165
	4	--	172	160	213	194	200
#2	1	211	163	200	245	205	--
	2	179	157	180	200	181	150
	3	154	154	138	219	157	175
#3	1	147	163	129	227	185	186
	2	150	164	133	215	172	260
	3	--	231	162	233	225	244

Table 3. The percentage of ewes lambing of those put to the ram for intensively and non intensively managed ewes over the first 2 years of the study (ie. the first production cycle for intensively managed ewes).

	Breed of ewe					
	Col	Suff	Ramb	ColxFin	RambxFin	SuffxFin
Intensively managed ewes	76	70	73	80	75	90
Control ewes	74	82	90	99	95	89

Table 4. The number of lambs per 100 ewes lambing for intensively and non intensively managed ewes over the first 2 years of study (ie. the first production cycle for intensively managed ewes).

	Breed of ewe					
	Col	Suff	Ramb	ColxFin	RambxFin	SuffxFin
Intensively managed ewes	164	174	166	220	201	173
Control ewes	149	164	131	221	178	223

Table 5. The number of lambs born annually for a flock of 100 intensively or non intensively managed ewes.

	Breed of ewe					
	Col	Suff	Ramb	ColxFin	RambxFin	SuffxFin
Intensively managed ewes	186	184	181	263	226	234
Control ewes	110	135	118	219	169	199
% increased lamb production in intensively managed ewes	69%	36%	53%	20%	34%	18%

Table 6. Mean time from treatment with estradiol benzoate to parturition in ewes bred in the spring to synchronized estrus. Estradiol benzoate treatments were started on day 142 of gestation.

Group	n	mean ± SD
†8 a.m. TWICE	9	1904* ± 1013
8 p.m. TWICE	9	1967 ± 852
8 a.m. ONCE	9	2071 ± 817
Controls	12	3095 ± 1706

*Minutes from first injection to parturition.

†See experimental methods section for details of treatments.

APPENDIX

A. Feeding Regime (CP, TDN expressed as % of DM) for Intensively Managed Ewes (Groups 1 and 2)

a) Flushing ewes for breeding and early pregnancy
(start 3 weeks before breeding date of first bred ewes and continue until 5 weeks after second breeding)

requirements: 1.5 kg DM 9% CP 56% TDN

met by:	0.6 kg DM barley	(elevator)
	0.9 kg DM hay	(Smith Grass/Alfalfa (49))
	(10.95% CP, 58.60% TDN)	
as fed:	0.68 kg barley	(1.5 lbs)
	1.00 kg hay	(2.25 lbs hay)

b) Mid pregnancy
(from 5 weeks after second breeding to day 100 of gestation for first bred ewes)

requirements: 1.4 kg DM 9% CP 53% TDN

met by:	0.30 kg DM barley	(elevator)
	1.10 kg DM hay	(Winisky brome, feed equal amounts of 52/53)
	(9.07% CP, 55.05% TDN)	
as fed:	0.33 kg barley	(0.75 lbs)
	1.22 kg hay	(2.75 lbs)

c) Late pregnancy
(from 100 days gestation for first bred ewes until lambing is complete for all ewes)

requirements: 2.1 kg DM 9.5% CP 60% TDN

met by:	0.69 kg DM barley	(elevator)
	1.38 kg DM hay	(Bitz hay #46)
	(13.11% CP, 62% TDN)	
as fed:	0.79 kg barley	(1.75 lbs)
	1.59 kg hay	(3.5 lbs)

d) Early lactation
(from first lambing to 4 weeks after the 2nd lambing)

requirements:	Singles	2.6 kg DM	12% CP	64% TDN
	Twins	2.8 kg DM	13% CP	66% TDN
	Triplets	3.0 kg DM	13.5% CP	67% TDN

met by:	Singles	1.17 kg DM barley	(elevator, 9% CP)
		1.43 kg DM hay	(Bitz (46) mixed equally with oat hay (45))
as fed:		1.32 kg barley	(3 lbs)
		1.62 kg hay	(3.5 lbs)
met by:	Twins	1.26 kg DM barley	
		1.54 kg DM hay	
as fed:		1.43 kg barley	(3.25 lbs)
		1.75 kg hay	(4 lbs)
met by:	Triplets	1.35 kg DM barley	
		1.65 kg DM hay	
as fed:		1.53 kg barley	(3.5 lbs)
		1.98 kg hay	(4.5 lbs)

All lactating ewes fed at 13% CP, 67% TDN for simplicity, presumably ewes will regulate intake accordingly.

e) Late lactation
(from 4 weeks after the 2nd lambing to weaning)

requirements:	Singles	2.2 kg DM	10% CP	62% TDN
	Twins	2.4 kg DM	10% CP	62% TDN
	Triplets	2.6 kg DM	10% CP	62% TDN

met by:	Singles	0.9 kg DM barley	(elevator)
		1.3 kg DM hay	(Winisky brome 52/53)
as fed:		1.0 kg barley	(2.25 lbs)
		1.45 kg hay	(3.25 lbs)
met by:	Twins	1.0 kg DM barley	
		1.4 kg DM hay	
as fed:		1.11 kg barley	(2.5 lbs)
		1.56 kg hay	(3.5 lbs)
met by:	Triplets	1.1 kg DM barley	
		1.5 kg DM hay	
as fed:		1.23 kg barley	(2.75 lbs)
		1.67 kg hay	(3.75 lbs)

f) Maintenance
(beyond weaning to start of flushing, 2 weeks in intensive ewes)

requirements: 1.3 kg DM 9% CP 51% TDN

met by: 0.26 kg DM barley (elevator)
1.04 kg DM hay (Winisky brome 52/53)
(8.98% CP, 54.6% TDN)

as fed: 0.29 kg barley (0.75 lbs)
1.16 kg hay (2.5 lbs)

Ewes go onto this 2-3 days before lambs are removed

B. Control Ewes (Group 3) - same rations as used for intensively managed ewes (Groups 1 and 2)

a) Flushing and early pregnancy - for a 12 week period beginning 3 weeks before breeding

b) Mid pregnancy - from end of "a" above to 100 days of gestation (approximately 8 weeks of feeding)

c) Late pregnancy - 100 days of gestation until lambing is complete

d) Early lactation - lambing to 4 weeks after lambing

e) Late lactation - from 4 weeks after lambing until weaning

f) Maintenance - from weaning to flushing

C. Rams - same rations as for intensively managed ewes (Groups 1 and 2) but twice the amounts

a) Flushing and breeding - begin 4 weeks before and finish at the end of the breeding period

b) Maintenance - from the end of breeding until 4 weeks before the next breeding period

D. Lambs - lambs are offered a Starter Creep Ration in meal form as follows, from 5 days of age until weaning at 50 days.

Ingredient	Percent
Wheat (dry rolled)	72
Soybean meal	10
Biophos (Ca-P source)	0.7
Ground limestone	0.8
Cobalt-iodized salt	0.5
White salt	1.0
Ammonium chloride	0.5

Alfalfa meal (dehy)	10
Tallow (oil)	1.0
Molasses	2.0
Supplement[1] (LS106 + Aureo SP250)	1.5

[1] Vit A and D_3 in a barley carrier plus 15g Aureo SP250 provides 2700 I.U. Vit A and 600 I.U. Vit D_3 per pound of ration.

- At 3 weeks of age lambs are offered a pelleted (3/16") Grower-Finisher Ration as follows in addition to the Starter Creep Ration, so they become accustomed to it by weaning time.

Ingredient	Percent
Barley (dry-rolled)	60
Soybean meal	5
Cobalt-iodized salt	0.5
White salt	1.5
Ammonium chloride	0.5
Dical-Phosphate	0.5
Alfalfa (suncured dehy)	30
Tallow (oil)	1.0
Supplement[1] (LS106 + coccidiostat)	1.0

[1] Vit A and D_3 in a barley carrier + 0.25 lb Avatec Premix/10 lb of LS106 provides 1800 I.U. Vit A and 400 I.U. Vit D_3 per pound of ration.

Feeds Allocated to Sheep

			% of DM		
		(H_2 %)	% CP	% TDN	Ca/P
Winisky Brome	(52/53) (average)	11.6	7.76	48.25	low
Smith Grass/Alfalfa	(49)	10.5	11.16	43	P low
Bitz hay	(46)	13.1	14.64	53	ok
Oat hay	(45)	14.4	15.68	57	ok
Smith Alfalfa	(48)	13.0	14.63	46	P low
Barley (elevator)					
TDN of forages calculated from ADF					
TDN on grains estimated					

General

Feed changes for ewes should be done over 2 to 4 days.

Feed free-choice a loose mineral-vitamin mix including salt (Co-op Sheep Mix with low copper) as well as a separate source of cobalt-iodized salt.

Lactating ewes should be fed according to number of offspring, ie: split into separate pens. Otherwise feed the crossbred ewes apart from the purebreds and ensure adequate hay feeder and grain through space (18" per ewe).

The actual daily intake should be governed by the body condition of the ewes and rams relative to that required by the stage of the production cycle they are in. The "Condition Scoring" system to be used is as follows:

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FINAL

Intensification of Sheep Production Under Prairie Conditions

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Lay Summary

A flock of 288 Rambouillet, Suffolk, Columbia, Finn x Rambouillet, Finn x Suffolk and Finn x Columbia ewes were maintained over a 3 yr period. One group of ewes (control) were bred once per year (October). The other two groups of ewes (intensively managed) were bred every 8 mo, but the breedings were staggered so that the two flocks lambed 4 mo out of phase with each other. Estrus was synchronised in intensively managed ewes using intravaginal sponges impregnated with medroxyprogesterone acetate. Breedings occurred in January, May and September. Artificial lighting was used to induce estrus for out of season breeding. The percentage of ewes lambing of those put to the ram averaged 88% for breedings in January, September or October and 64% for May breedings. Lambing percentage (number of lambs per 100 ewes lambing) was higher for crossbred (216%) than purebred ewes (165%), it was 172% followed breedings in May and averaged 192% for breedings in January, September or October. Intensive management resulted in an extra 37% lambs weaned and spread lamb supply across the year. The crossbred ewes weaned an average of 226 $\pm$ 10 lambs per 100 ewes under intensive management, with a high of 283 $\pm$ 26 for the Finn x Columbia ewes.

Summary

A flock of 288 Rambouillet, Suffolk, Columbia, Finn x Rambouillet, Finn x Suffolk and Finn x Columbia ewes were maintained over a 3 yr period. One group of ewes (control) were bred once per year (October). The other two groups of ewes (intensively managed) were bred every 8 mo, but the breedings were staggered so that the two flocks lambed 4 mo out of phase with each other. Estrus was synchronised in intensively managed ewes using intravaginal sponges impregnated with medroxyprogesterone acetate. Breedings occurred in January, May and September. Estrus was induced by photoperiod manipulation for out of season breeding. The percentage of ewes lambing of those put to the ram was affected by the season in which breeding took place, but not by breed or management regimen (January 93 ± 1%, May 64 ± 5%, September 81 ± 3%, October (control) 90 ± 3%). Lambing percentage (number of lambs per 100 ewes lambing) was higher for crossbred (216 ± 10%) than purebred ewes (165 ± 8%) and varied with season. The poorest figures followed breeding in May (172 ± 6%) compared to the January, September or October breedings (207 ± 11%, 180 ± 7%, 190 ± 10%). Annual lamb production to weaning was increased 37 % by intensive management. The crossbred ewes produced an average of 226 ± 10 lambs per 100 ewes under intensive management, with a high of 283 ± 26 for the Finn x Columbia ewes. Lamb weights at weaning were slightly lower under

intensive management (16.7 ± .1 kg) when compared to controls (17.7 ± .1 kg), but lamb losses were similar for the two management regimens. Intensive management increases productivity and spreads the supply of lamb across the year, facilitating orderly marketing.

(Key Words: Sheep, Breeds, Intensified production, Reproductive manipulation)

Introduction

In Western Canada, as in other areas of North America, sheep production is of minor and declining importance (Homer et al., 1980). Although the potential exists for high levels of productivity (Jeffcoate et al., 1984), industry development is hampered by poor fertility and output of finished lambs and the seasonality of production creates a severe problem for orderly and effective marketing. Productivity can be improved by good management and the introduction of prolific breeds of sheep (Jeffcoate et al., 1984). In addition, by employing various techniques for reproductive manipulation, it should be possible to increase the frequency with which ewes lamb and to remove the seasonality of production (Ainsworth et al., 1976; Thimonier and Cognie, 1977; Rawlings et al., 1983). However, the commercial application of intensified production has been limited. The

purpose of the present study was to examine the performance of Suffolk, Columbia and Rambouillet ewes, and their Finn half-crosses, in an intensified production scheme aimed at increasing lamb output and eliminating the seasonality of lamb production. An emphasis was placed on simplicity, minimal capital outlay and commercial applicability. The ewe breeds were those that form the base for local sheep production.

Materials and Methods

A flock of 288 ewes was maintained over a 3 yr period. The flock was made up of equal numbers of the following breeds or breed types: Rambouillet (Ramb), Suffolk (Suff), Columbia (Col), Finn x Rambouillet (Finn x Ramb), Finn x Suffolk (Finn x Suff) and Finn x Columbia (Finn x Col). The crossbred ewes were produced from within the flock. The Finn rams, Suffolk and Hampshire rams used as terminal sire crosses, and purebred ewes, were all commercial grade animals purchased from local producers. The flock had not undergone extensive selection and the average age of the ewes during the 3 yr study was 3.7 yr. All animals were housed in dry lots with open fronted shelters. When a ewe lambed, the ewe and lamb were transferred to a 1.5 x 1.5 m claiming pen in a barn, for a period of 1 to 3 d. The barn was heated to 5 to 10 C in winter time. The typical annual temperature range for Saskatoon (52 09'N, 106 36'W) is -35 C to +35 C.

The nutritional regimen was based on the National Research Council (N.R.C, 1968) recommendations and utilised alfalfa and alfalfa-brome hay mixtures, with barley as a grain supplement. Water and mineral supplement were available free choice. The early lactation ration was fed for 4 wk. Following weaning, which occurred when lambs were 7 wk old, a maintenance ration was fed. Flushing was done for 4 wk prior to breeding. In intensively managed ewes, flushing started 10 d after weaning. Ewes were weighed at breeding, immediately following lambing and at weaning. Lambs were weighed at birth and weaning.

The flock was split into three groups, each containing 16 ewes of each of the breeds or breedtypes above. One group of ewes served as a control flock; ewes were bred naturally each October. Ewes in the other two groups were bred every 8 mo, with the two groups lambing 4 mo out of phase with each other (intensively managed ewes). The breedings occurred in January, May and September. At every breeding purebred ewes were placed with Finn rams, and 50% of the crossbred ewes were placed with Suffolk rams and 50% with Hampshire rams. Rams were semen tested twice a year and introduced at a ratio of 1 ram to 10 ewes. The rams were left with the ewes in the control flock for 35 d.

The intensively managed ewes were bred at estrus synchronised by a 12 d treatment with intravaginal sponges containing 60 mg medroxyprogesterone acetate ("Veramix"[7]). Each ewe received 500 IU PMSG ("Equinex[8], im) at sponge removal. Rams were introduced

7. Tuco Products Co., Orangeville, Ontario, Canada.

8. Ayerst, Winnipeg, Manitoba, Canada.

24 hr after sponge removal and left with the ewes for 25 d. Ewes to be bred in May were subjected to 18 hr of light per day in the preceeding January. This was followed by a reduction in daylength of 45 min per wk until breeding. Rams were housed in pens adjacent to the ewes and exposed to the same photoperiod changes for the May breedings. Daylength manipulation was achieved using a pole barn which was light proofed with wood shutters and black polyethylene. The barn was illuminated by 200W incandescent lights, spaced at 3 m intervals and controlled by an automatic timer. Light intensity at the ewes' eye level varied from 150 lux below the lights to 50 lux at the most distant point from the lights.

Blood samples (3 ml) were taken by jugular venipuncture 20 and 95 d after sponge removal from intensively managed ewes for pregnancy diagnosis. The was based on concentrations of serum progesterone. Ewes found to be nonpregnant 95 d after breeding in the intensively managed flocks were transferred to the other intensively managed group of ewes, to be rebred. Any ewe failing to lamb in response to two consecutive breedings was culled.

Progesterone was quantified by a previously published radioimmunoassay (Rawlings et al., 1984). The intra- and interassay coefficients of variation were 10% (n=13) and 22% (n=31) respectively. Five picograms of progesterone significantly displaced the labelled ligand from the antiserum ($P < 0.01$, n=30).

Data were summarised as means and standard errors.

Statistical analysis involved analysis of variance and Student Newman Keuls multiple range test (Sokal and Rohlf, 1969). Significance is expressed at the 5% level ($P < 0.05$), unless otherwise indicated.

Results

Over the 3 yr period of study 3 lambings were recorded for the control flock and a total of 9 lambings for the two intensively managed flocks. In the intensively managed flocks data were collected for a total of 3 lambings following breedings in each of January, May and September. In tables 1 and 2 the number of ewes lambing of those exposed to the rams and the lambing percentage (number of lambs per 100 ewes lambing) are shown. Results are given for ewes of each breed or breed cross in the control flock following October breeding and the intensively managed flocks following January, May and September breedings. The season of breeding affected both the number of ewes lambing and the lambing percentage. Combining the data for all breeds (right hand column, table 1), it was seen that breedings in October (control) and January resulted in the highest numbers of ewes lambing. May breeding resulted in the lowest number of ewes lambing and Preeding in early September produced intermediate results. Although a similar trend was apparent for lambing percentage (right hand column, table 2), only the results

following May and January breedings differed significantly. The number of ewes lambing was not significantly affected by the breed of ewe (lower row, table 1), although the Finn x Suff ewes appeared to produce the best results. When the data for all seasons were combined, the Finn cross ewes were shown to have a higher lambing percentage than the purebred ewes (lower row, table 2). This was not significant in each breed and breed cross comparison in table 2 , but overall lambing percentage was 165 $\pm$ 8 for purebred ewes and 216 $\pm$ 10 for Finn cross ewes. Table 3 shows the average number of lambs born annually for a flock of 100 intensively or nonintensively managed ewes, based on the data in tables 1 and 2. Annual lamb production was increased by intensified management (right hand column, table 3), although a significant increase was not recorded for each breed. Overall, the crossbred ewes produced more lambs per year than the purebreds (231 $\pm$ 9 vs 166 $\pm$ 10 $P < 0.05$) but again, when considering comparisons between individual breeds and breed crosses, production was not significantly higher in all cases (table 3).

Lamb losses to weaning were not influenced by management regimen or season. They appeared to be lower for lambs produced by purebred ewes (11 $\pm$ 4%), compared to crossbred ewes (15 $\pm$ 4%), however this was not significant ($P > 0.1$). Annual ewe replacement rate was 17 $\pm$ 2% for the control flock and 25 $\pm$ 3% for the intensively managed ewes. Of the ewes culled, 25 $\pm$ 9% were culled, or died, due to chronic wasting conditions, 20 $\pm$ 6%

were culled because of mastitis. There was no difference in incidence due to management regimen. The incidence of culling for infertility was greater in the intensively managed flocks (15 ± 5%) than in the control flock (4 ± 3%). No clearly specific causes were evident or recorded for the remaining losses.

Ewe body weight was affected by breed, stage of production and management regimen, but not season of breeding. Ewe body weights at breeding, after lambing and at weaning for intensively managed and control ewes were 70 ± .4 kg, 69 ± .5 kg; 74 ± .5 kg, 69 ± .4 kg; and 69 ± .5 kg, 61 ± .4 kg respectively. Lamb weights at birth were affected by season of breeding, but not management regimen (September: 4.3 ± .05kg; October (control): 4.1 ± .05 kg; May: 3.8 ± .07 kg; Jan: 3.9 ± .04 kg). Lambs born following breedings in September were heavier than following breedings at all other seasons. This seasonal influence was not reflected in weaning weights, but ewes from the control flock weaned heavier lambs (17.7 ± .1 kg) than ewes from the intensively managed flocks (16.7 ± .1 kg). There were no significant effects of breed on lamb birth weight, but Suff and Ramb ewes tended to produce the heaviest lambs (4.4 ± .1 kg and 4.4 ± .1 kg) and Finn x Col ewes the lightest (4.1 ± .2 kg). Again, weaning weights did not vary significantly with breed, but the Suff and Finn x Suff ewes appeared to wean the heaviest lambs (18.1 ± .1 kg and 17.4 ± .1 kg) and the Col ewes the lightest lambs (15.7 ± .1 kg).

Discussion The higher lambing percentage noted in the Finn cross ewes compared to purebred ewes in this study reflects that observed in previous studies (Dickerson, 1977; Branford Oltenacu and Boylan, 1981). The variation in the number of ewes lambing and lambing percentage following breedings in September, October (control) or January would appear to reflect an increase in ovulation rate and fertility as the breeding season progresses and not an effect of the increased production pressure applied to intensively managed ewes (Ducker and Boyd, 1974; Wheeler and Land, 1977). Breeding out of the regular breeding season resulted in a lower number of ewes subsequently lambing and a lower lambing percentage, despite photoperiod manipulation of the ewes and rams. The photoperiod regimen used in the present study has been shown to successfully induce estrous cyclicity (Robinson et al., 1975; Jeffcoate et al., 1984). In our own flock, in a previous study, using ewes that had been open for one year, fertility to out of season breeding was excellent using the photoperiod regimen mentioned above (Jeffcoate et al., 1984). This would indicate that the reduced fertility noted in the present study was probably due to production pressure, even though the nutritional regimen appeared to maintain body condition at higher levels than noted in control ewes. This perhaps emphasises the need to evaluate controlled breeding or

intensive production techniques over a reasonably long time period.

It is clear that the intensive management scheme increased ewe productivity (table 3). However, productivity was not increased to the predicted 50% in most breeds. This discrepancy largely reflects the reduced fertility of ewes at the breeding out of season, in May. There did not appear to be a cumulative or consistent reduction in productivity due to intensification. With the nutritional regimen used, intensively managed ewes were consistently capable of equal production to control ewes, following breedings during the normal breeding season. Increased lamb production is of no use if lamb losses increase in parallel, or if lamb growth is severely impaired. From this study it was clear that intensification did not produce higher lamb losses, but good management is clearly necessary to preserve the increased lamb crop from the prolific Finn cross ewes. Intensively managed ewes did wean lighter lambs than control ewes, but the differences in weights were not large. The turnover of ewes from the intensively managed flocks was high. Unfortunately it was not possible to accurately identify the causes of this. Presumably in a relatively unselected group of commercial ewes the pressures of intensification increased the annual attrition rate. With time and selection this rate of attrition should fall. The crossbred ewes produced more lambs and lamb weaning weights did not differ significantly between breeds; therefore,

based on our observations, the Finn x Col ewe would appear to offer the highest productivity under our intensive management regimen. The level of productivity achieved by these ewes resembles that achieved by Finn cross ewes in previous studies (Vesely and Swiestra, 1985).

Our approach to intensification was to use methods, husbandry and facilities that were straight forward and did not require a large outlay of capital. The sheep were taken from the local population, such that the breeds used would be readily available to producers at a reasonable price. The productivity achieved compares well to other more capital intensive schemes, using breed crosses developed and selected over long periods of time (Ainsworth et al., 1976; Vesely and Swiestra, 1985). In the present scheme productivity would be expected to increase as selection pressure is brought to bear. The use of such a scheme reduces the nonproductive period of the ewes' annual production cycle and increases the ewes annual output of lamb. In addition, the seasonality of lamb production is removed, allowing the producer to take advantage of seasonal peaks in lamb prices and also to enter into year round supply contracts. One of the major constraints to orderly lamb marketing is the seasonality of production. An economic evaluation of this intensive production scheme is now in progress.

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TABLE 1. THE PERCENTAGE (MEAN ± S.E.) OF EWES LAMBING OF THOSE EXPOSED TO THE RAMS FOR EWES BRED ONCE A YEAR AT NATURAL ESTRUS (CONTROL) AND FOR EWES ON A CYCLE OF 3 LAMBINGS IN 2 YEARS. RESULTS FOR THE LATTER EWES ARE GROUPED ACCORDING TO THE MONTH OF BREEDING. THE TRIAL WAS RUN FOR 3 YEARS

	Breed of Ewe						
Month of breeding	Ramb	Suff	Col	Finn x Ramb	Finn x Suff	Finn x Col	Overall
January	94 ± 1[a]	90 ± 5	93 ± 3	94 ± 3[a]	97 ± 4	95 ± 2	93 ± 1[a]
May	52 ± 13[b]	65 ± 15	57 ± 2	61 ± 12[b]	90 ± 10	66 ± 10	64 ± 5[c]
September	83 ± 7[a]	81 ± 9	78 ± 11	80 ± 1[ab]	89 ± 1	78 ± 8	81 ± 3[b]
Control (October)	93 ± 5[a]	82 ± 5	74 ± 17	92 ± 1[a]	97 ± 2	99 ± 1	90 ± 3[a]
Overall	81 ± 6	80 ± 5	75 ± 6	82 ± 5	94 ± 2	85 ± 5	

Numbers in columns followed by different superscripts are significantly different ($P < .05$).

TABLE 2. THE LAMBING PERCENTAGE (NUMBER OF LAMBS PER 100 EWES LAMBING, MEAN ± S.E.) FOR EWES BRED ONCE A YEAR AT NATURAL ESTRUS (CONTROL) AND FOR EWES ON A CYCLE OF 3 LAMBINGS IN 2 YEARS. RESULTS FOR THE LATTER EWES ARE GROUPED ACCORDING TO THE MONTH OF BREEDING. THE TRIAL WAS RUN FOR 3 YEARS

	Breed of Ewe						
Month of breeding	Ramb	Suff	Col	Finn x Ramb	Finn x Suff	Finn x Col	Overall
January	175 ± 14^{2}	177 ± 15^{2}	198 ± 33^{2}	224 ± 17^{2}	179 ± 13^{2}	279 ± 21^{a1}	207 ± 11^{a}
May	155 ± 9	176 ± 11	147 ± 7	175 ± 13	169 ± 7	202 ± 18^{b}	172 ± 6^{b}
Sept	165 ± 7	168 ± 6	146 ± 14	203 ± 16	175 ± 25	209 ± 5^{b}	180 ± 7^{ab}
Control (Oct)	141 ± 10^{2}	186 ± 22^{12}	149 ± 2^{12}	194 ± 16^{12}	230 ± 23^{1}	225 ± 5^{a1}	190 ± 10^{ab}
Overall	159 ± 6^{3}	177 ± 7^{23}	160 ± 11^{3}	199 ± 9^{2}	193 ± 12^{23}	229 ± 11^{1}	

Different letter superscripts in columns and different number superscripts in the rows show significant differences ($P < .05$).

TABLE 3. THE NUMBER (MEAN ± S.E.) OF LAMBS BORN ANNUALLY FOR A FLOCK OF 100 INTENSIVELY OR NONINTENSIVELY MANAGED EWES BASED ON DATA IN TABLES 1 AND 2, FOR A 3 YEAR TRIAL PERIOD

	Breed of Ewe						
	Ramb	Suff	Col	Finn x Ramb	Finn x Suff	Finn x Col	Overall
Inten Managed	191 ± 13^{a*}	206 ± 22^{a}	196 ± 8^{a**}	241 ± 9^{ab*}	239 ± 12^{ab}	283±26^{b**}	226 ± 1
Control Ewes	132 ± 16^{ab}	152 ± 19^{ab}	116 ± 15^{a}	184 ± 16^{ab}	216 ± 36^{b}	223 ± 5^{b}	170 ± 1
% diff	45%	36%	64%	31%	11%	27%	37%

Different letter superscripts in rows show significant differences ($P < .05$). * ($P < .05$) and ** ($P < .01$) show significant differences in columns.